EDITORIAL ARTICLES.

CHIPAULT ON THE SURGERY OF THE SPINE AND SPINAL CORD.[1]

THIS article is a continuation of the one which appeared in the same periodical in August, 1892, and which formed the basis of an editorial digest in the ANNALS OF SURGERY, December, 1892.

In performing laminectomy for the relief of traumatic lesions it is not now considered sufficient for the operator to content himself simply with the removal of a greater or lesser number of arches, but in order to make the procedure complete it is essential that the dura mater should be opened and the intra-dural and medullary lesions treated. By this means the value of the operation has been enhanced. Out of 160 cases analyzed by Chipault, 20 were cured, 33 were improved, 22 gave no improvement, and there were 65 deaths and 15 unknown results.

This proportion of successes to deaths is decidedly discouraging. The deaths were all due, however, with the exception of two cervical cases that died from operative hæmorrhage, to one of the three following causes:

(1) The extreme gravity of the traumatism, the injury soon affecting the respiratory centre, or else there were lesions of other organs also present.

(2) Infection through the operative wound, which was so grave and so frequent an accident in pre-antiseptic days.

(3) Infection through the lungs, bladder or bed sores consequent upon the injury of the spinal cord.

The first class are naturally beyond surgical assistance, the second should not be considered at the present time, while the third can be controlled somewhat by antisepsis of the bladder and the ulcerations.

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[1] Revue de Chirurgie, March, 1893.

When a traumatism involves only the cauda equina the operation must be performed below the first lumbar vertebra, the cord ending at this level in adults, when the head and trunk are flexed. There have been many successful operations for fractures below the level of the twelfth dorsal vertebra. In delayed operations less perfect but satisfactory results have been obtained even at times after incomplete intervention.

In some cases where the condition had remained stationary for months, or even years, an ordinary amount of motion and sensation has been regained after operation. The therapeutic result in these cases required weeks before it became evident, and months before it reached completion.

The nerves of the cauda equina, like those of the periphery, are decidedly resistant to traumatisms. Whether compressed or divided, they recover as soon as the compression is removed, or the severed ends united. Even when the operation is delayed for a long time complete recovery should result from thorough surgical interference, unless there is secondary degeneration of the cord, or unless instead of the nerves, which recover so well, the canal is occupied by ganglions which do not recover.

A study of the cases of injury in this region leads to the conclusions that where there is lumbar or sacral fracture, with permanent and irreducible bony displacement, operation should be done at once. Where the fracture has been replaced spontaneously, or by surgical means, wait; if the indications point toward recovery, let it alone; if there is no change of any kind, operate about the end of the first month, not sooner, because there will be no functional recovery earlier than this, and no further delay should be allowed, lest incurable medullary degeneration set in.

In the operations for fractures involving the cord the results have been uncertain and usually unsuccessful. The majority survived the operation, but were not benefited, and died of exhaustion or pyelonephritis. Some slight improvement has been noted in cases where the nerve roots arising from a segment above the injured one have been involved, and have recovered their function after the removal of the compression. This has not been so frequently the case in the upper dorsal and cervical regions as it has in the lower dorsal. Besides these cases of nerve repair there is a small number where the improvement is not only due to the nerve repair, but to the cord also. A careful study of these cases in comparison with others less fortunate but more frequent help us to form conclusions in regard to the probability of success following operation in a given case. Consider then, first, fractures confined to the arches; second, transverse complete fractures, or fractures of both the body and the arches.

Tillaux considers that the former are the only ones offering any hope to the surgeon. They are favorable for interference because the compression is caused simply by the pressure of the fragments, and not, as in complete fractures, by the weight of a portion of the body that forces the upper segments of the spine down upon the displaced lower segment. Here the injury to the spinal cord is due simply to splinters, and there is no degeneration from compression or elongation of the spinal cord as is usually the result in fractures involving both arch and body. In this class of cases, too, only the posterior columns are usually wounded, and they seem better able to resist compression and even partial destruction than other parts of the cord.

Operation for these conditions should be undertaken early, for the fragments of the laminæ cut into the cord at each contraction of the sacro-lumbar muscles.

Complete transverse fractures are very different from the preceding, and present a number of varieties, which must be distinguished in order to determine the indications and surgical methods of treatment:

(1) The most common variety is where there is a permanent bony compression between the body and the arch.

In a series of experimental fractures in twenty-four children and eight adults, where the cord was either badly contused or entirely severed, the bones were found in place, and constant bony replacement would be considered as the rule were it not for the hundreds of cases on record where autopsies and operations have proven the existence of a permanent bony displacement.

It is possible that these differences of opinion may be explained by the supposition that these displacements are corrected spontaneously after death, when there has been no callus to fix the fragments. In general, however, it may be said that in complete transverse fractures there is during life always, or nearly always, a permanent bony compression.

Chedévergne says that the cord is cut by the sharp outer edge of the vertebra, as it is stretched across the fragment. This stretching is easy, because the cord is bound at different points by ligaments from the pia mater, and the cord soon loses most of its elasticity. Other authorities, however (Chipault, Félizet, Minard), do not consider the edge of the vertebra, no matter how sharp it may be, sufficient to cause the spinal compression. It really only compresses the meningeal sheath, which is free enough in the canal to allow of its being lifted a centimetre from the vertebra. Permanent bony compression is made then not by the body alone, but by a compression between the body and the arch. The failure of the operation of opening the spine in these cases, where theoretically it should be so successful, may be due to either of the following causes:

Incomplete or too timid interference. Most surgeons have been content to remove one or two arches and make only an exploratory operation, while to be successful not only the posterior but the anterior compressing factor should be reached. After freeing the sheath the edge of the projecting vertebra should be removed or the displacement reduced by direct measures; the dura mater should then be opened and the clots removed, and the adhesions which interfere with the free circulation both of the blood and the cephalo-rachidian fluid should be broken down. The severed nerve roots may then be reunited either to their own roots or to roots arising from spinal segments above the point of injury. Repair of the cord, if it is completely crushed or seriously injured, is impossible, because of the extent of the sclerosis and secondary degeneration that follow these injuries.

Interference has been undertaken too late. This is a frequent cause of failure. In two or three days after the injury myelitis sets in, and, perhaps, weeks later sclerosis. After the third or fourth month the cord tissue has been converted into a mass of cicatricial tissue.

If the conditions of the parts allow of an operation it should be undertaken early, after only a few days have elapsed, before the injured portion of the cord has been destroyed by the persistent interference with the circulation. In studying the cases of trephining for permanent compression of the cord between the body and the arch we see that delayed operations have never given satisfactory results, while the contrary is true in nearly all the early cases. Consequently, in future, early rather than late interference should be the rule. Where the operation has been delayed ten or twelve or more months the cord has been found completely sclerosed, reduced to a cicatricial band, and more or less stretched. In this case there is often very little improvement, not enough to really benefit the patient.

On the other hand very early operation shows, occasionally, considerable benefit, and even some complete recoveries. Improvement, when it comes, begins by the sudden and almost immediate return of sensibility. Motor repair is slower, but progressive from above down. Sometimes in operations in these early cases recovery of function has not been satisfactory.

Leaving out of consideration cases that are *in extremis* we can readily recognize two causes for the partial or total failure of the operation.

The high position of the injury.—Whatever may be the cause, operations in the cervical or cervico-dorsal regions have been very unsatisfactory. All the successes belong to the mid-dorsal, or to the region of the *conus medullaris.* The next cause of failure is *the severity of the injury.*

It is safe to conclude then that in cases of permanent compresson between the body of the vertebra and the arch interference having given beneficial results, it should be performed

(1) Very early.

(2) When the traumatism has affected the lower and not the upper part of the cord.

(3) When the cord lesion has been simply a compression, and not a destruction of the cord.

The youth of the patients also affects the chances of obtaining a good result from delayed operation.

In cases of fracture where permanent bony compression was produced either by the edge of the vertebral body, or by the arch being either partially or completely pushed into the canal, or where the compression has been due to callus, it is plain that the first would offer but slight hope of recovery, the second would be better, and the third, being a slow rather than a sudden compression, would allow of comparatively late interference.

In cases where laminectomy is indicated it is superior to a simple reduction of the fragments. This is evident in fractures of the arches, reduction having no effect upon isolated fragments. This is plain, because reduction has been of benefit only in cases where laminectomy was also employed, fractures in the region of the cauda equina and low recent fractures, without any serious nervous lesion. Reduction is also only applicable to bony displacement. It is useless where there are clots or adhesions which, if they persist, are sufficient in themselves to account for the spinal disturbance, and which can only be discovered and treated by a laminectomy. Reduction has, even when most carefully performed, sometimes aggravated the lesion, and hastened death.

In some cases, however, where laminectomy is contra-indicated, reduction has given good results as, for instance, in cases of cervical luxation without fracture. In these cases, if recent, slow reduction has given much success, if old a rupture of the adhesions by the manipulations might be the beginning of recovery. This is not applicable to cases which are complicated by fractures which are still beyond every effort of the surgeon.

It is possible to still more improve the prognosis of reduction in simple cervical luxations by making this reduction with the arches exposed, and employing a silver wire suture of the special processes to prevent the relapses which are sometimes sure. Hadra attempted this without success, but in his case the suture broke, and the wound suppurated.

Fractures from Firearms.—Fractures without penetration of the spinal canal by splinters, or by the ball, are much the most favorable for treatment, particularly where only the spinal processes are involved. At the present time the projectile could be removed at once, and the wound rendered surgically clean.

Exceptions to this, however, should be noted in the throat and neck, where almost always the trachea, pharynx or large vessels are wounded. Fractures of this kind show that *peri-* and *para*-medullary lesions may be favorable for recovery, but where the cord is involved the results are disastrous. Visceral complications also increase the gravity of the lesion.

In all these cases, where there is no opening of the canal, there may appear at the time of the injury, or just after it, some more or less serious complication due, perhaps, to hæmato-rachis, or, perhaps, to capillary hæmorrhage into the cord. These conditions scarcely aggravate the prognosis. But in cases where these symptoms occur months or years after the injury, due either to slow progress of the sclerosed lesion at the side of the cord or nerve roots, to ostitic lesions of the vertebræ, hyperostosis causing compression or sinking of a diseased vertebra, little benefit has been obtained from treatment.

In cases of penetration of the vertebral canal if there is simple and slight compression by a splinter, or by the projectile protruding into the canal without crossing it, and particularly if the traumatism is level with the *cauda equina*, and not in the cord itself, functional recovery is possible. Where, however, the projectile remains lodged in the canal the result is negative, and this is also true when it traverses the canal and penetrates the opposite wall. The cord in this latter case is crushed, perforated, or completely destroyed, perhaps for a long distance if the ball after entering the canal has been deflected from its course, and operation in these cases can only prevent meningeal infection.

Wounds of the Spine by Blunt, Cutting, or Pointed Instruments.—This class of injuries are rarer than the preceding varieties. The aim here should be to avoid meningeal infection, and to put the cord in the best condition for repair. The first indication is to close the meningeal opening in those exceptional cases where there is no lesion of the cord, but where a fistula has formed, allowing of the escape of cerebro-spinal fluid; the wound should always be rendered aseptic. It is more difficult to determine the procedure in cases where there is a fistula, not intra-medullary and without injury to the cord, but giving exit to pus which flows from a fragment of the weapon which has remained fixed in the spine.

In cases of section of the cord by a cutting instrument, an early and complete operation will lessen the mortality and give better functional results. Extraction of the foreign body if it has lodged in the wound, in any case to enlarge the wound, remove the splinters and arches, the intra- or extra-meningeal clots, and finally draw together the medullary wounds is essential to a proper recovery.

This done immediately after the injury, when the myelitis has not had time to change the condition of the separated surfaces, will, perhaps, allow of reunion by first intention.

Sgobbo says that repair of the cord is impeded only by the interposition between the two ends of a clot and then of a cicatrix; a rapid union would reduce these unfavorable conditions to the minimum and put these sections, whether complete or extended, that clinically could not recover in the same conditions as limited sections.

In old cases, or where traumatic myelitis and ascending and descending scleroses have affected the cord for any distance, any intervention is useless.

Vertebral Tuberculosis.—Spinal surgery of vertebral tuberculosis may be directed against bony lesions only, or against medullary complications.

Cases where the removal of a sequestrum or of diseased spinous processes at the base enables us to extirpate the whole disease are favorable when the operation is thorough. It may be necessary to follow granulations along the posterior face of the laminæ; complete operation may be more difficult and the benefit less constant and lasting where one or several laminæ, often with all or part of the articular processes, are also carious. In these cases the granulations may spread over the posterior surface of the dura mater and above and below under the healthy arches, forcing themselves in front and over the sides of the canal. It may often be that the vertebral bodies themselves are diseased. Exceptionally, the transverse processes may also be attacked.

In disease of the vertebral body, when confined to the lumbar region, Treves' method is applicable. When there is a lumbar abscess extending into the groin or thigh, the search for the diseased bony point is much simplified. Lumbar incision allows of direct treatment of the bony lesion without any trouble; if there is superficial caries, it may be scraped with a Volkmann's spoon, and if a sequestrum is present it can be grasped and removed with forceps, the bony fistula being enlarged, if necessary, with a gouge. If the abscess points in the lumbar region the opening should be made either where the abscess points, parallel to the last rib, for example, or better, by systematically following the external edge of the sacro-lumbar mass. The abscess pocket is then opened. But if there is an abscess pointing anteriorly or posteriorly where after ablation of the spine and scraping of the abscess walls it is still necessary to insert a drain to provide for future lavage, or where it is packed with iodoform gauze or simply dressed, recovery is very slow, the deep and tortuous cavity requiring weeks and months to close by granulation. During this time, of course, the patient is exposed to the dangers of suppurative changes, to secondary infection of the wound, and to visceral degeneration. Sometimes, too, a fistula requiring another operation results. Primary union may, however, be possible. Rigorous antisepsis and removal of diseased bone and fungous granulation tissue is necessary to accomplish this result. Fistulæ and infected pockets and abscesses with many diverticuli cannot be treated in this way, but must heal by granulation. Drainage and tamponing should also be employed if the lumbar incision leads to fistulæ arising in the sacral or dorsal vertebræ, where necessarily the operation cannot be complete, but where, nevertheless, it may be very successful.

Only exceptionally are the dorsal bodies accessible after lumbar incision. In order to reach this portion of the spine a more direct method must be employed. It is probably only practicable to reach them surgically when an abscess points behind, passing back between two costal heads.

The anterior portion of the cervical vertebræ is less accessible than the dorsal; thus usually the treatment of cold retro-pharyngeal or retro-œsophageal abscesses is limited to their incision through the mouth or laterally through the neck. These operations, however, are dangerous, incomplete and insufficient, and should only be undertaken as a palliative measure.

No special interest attaches to the study of posterior disease of the sacrum, but tubercular foci, sequestra, or areas of carious disease in the anterior sacral region, which are accompanied with perineal fistulæ (sometimes gluteal, inguinal or subiliac), are more difficult to manage and seldom successful. Cases of this kind often complicated with sacro-iliac tuberculosis are as discouraging as possible.

The tortuous, multiple and irregular fistulæ and the peri-fistulous sclerosis, as well as the advanced age of the patient, are all especially unfavorable for successful treatment.

If the disease affects the sacro-coccygeal region it is possible to resect 1½ to 2 centimetres of the bone without entering the spinal canal.

Trelat says that "cold abscess being a tumor composed of a fibrous wall and variable contents, must be removed or opened and its walls scraped, making a simple wound and treating it antiseptically. Where the bones are carious it is necessary to go down upon the bony lesion and treat it according to the requirements of the case.

Diverticuli must not be forgotten, as these starting points of the abscess frequently cause relapse. If this occurs they should be treated in the same way as the first tumor." In the vertebræ more than elsewhere the application of this ideal method meets frequent obstacles—due to the extent or the seat of the lesion. In these serious cases it is rare to obtain the desired result at the outset. Here, as in many bony tuberculoses a second, even a third operation may be necessary.

Where compression occurs in Pott's disease the course to be pursued varies. Cases where the bony lesions are limited to the arches, the pachymeningitic lesions of the epidural and subjacent dural zones are very favorable for operation; ablation of the sequestra and of the diseased bony fragments is easy, the region of the posterior tubercular pachymeningitis is very readily scraped and even completely removed, since it does not adhere to the underlying dura mater, which remains smooth, white and with almost a healthy appearance. Careful and complete removal of the diseased parts permits of a radical operation.

The posterior position of osteo-meningitic lesions is, however, exceptional, more often the bony lesion is in the vertebral bodies, and compression of the cord is from before backward by a bony projection, or a perimeningitis.

Antero-posterior compression by a bony projection can be either slow or sudden, both being exceptional. The first has often been denied; however, many surgeons have discovered a transverse bony edge projecting into the canal, and flattening the cord, in cases where the paraplegia had developed gradually.

Sudden bony compression results from a true fracture by a traumatism often slight, acting on already diseased vertebræ.

The results of surgical treatment in cases where the bony compression has been sudden indicate that there is no value in operation.

In the cases of slow bony compression the results are very prompt, remarkable, but quickly complicated by proliferation of tubercular granulations into the perimeningeal tissue.

This proliferation is usually the beginning of the paraplegia, the only cause of the accident.

In these cases most surgeons are content to remove a greater or less number of arches, that is to say, to relieve the cord posteriorly, in the hope that its elasticity will enable it to escape from the pressure of the granulations which force it back.

If the peri-meningitis spreads along the sides of the laminæ the tubercular products must be removed, but if it is found that the tuberculous tissue is apparently inaccessible, and spreads on the sides of the vertebral body between the nerve roots, and in contact with the articular processes which may or may not be carious, operation is useless. These cases require an operation which may at first appear to be successful, but which will finally lead to relapse. The granulations continue to proliferate, and compression of the cord first against the arches, and after their removal against the cicatrix, results. In spite of the unfortunate results reported in these cases the attempt has been made to attack this condition from the front.

Two methods have been proposed: one by dissecting around the spine; the other by trephining, pressing the cord to one side and treating the diseased body from the canal. These methods are difficult, and take for granted that the tuberculous lesion is not limited to posterior face of the vertebral bodies.

The method of operating usually adopted is to first lay bare the portion of the cord where the compression exists. This incision should be free enough to expose healthy tissue beyond the disease. The healthy tissue is covered by an adipose cushion through which the dura mater may be seen, stretched, elastic, bluish-white, and covered by several small longitudinal vessels, which are most abundant in the median line. The compressed portion of the cord is on the contrary completely deprived of normal adipose tissue, projects backward, is flattened and traversed by many vessels, which pulsate very slightly or not at all.

A sufficient number of arches should be removed to expose all these details, and to enable the operator to ascertain with the finger that there is no compression beyond.

The granulations can then be seen projecting between the nerve roots on one or both sides, forming a simple mass of tubercular tissue, or enclosing an abscess. In any case, by pushing the cord to one side and then to the other, and by lifting it from its bed the granulations may be extirpated; all the anterior peri-meningitis, so easily separable from the dura mater, may be removed, and the cavity in the vertebral body scraped out. Bony irregularities should be smoothed off, and all sequestra removed. This operation is easy since the space between the roots, large enough to allow of the passage of instruments along the side of the vertebral body in health, is still larger in Potts' disease. After thorough cleaning of the cavity it should be drained by a tube passing between the membranes and the canal to the lowest angle of the skin incision. Careful and repeated washings of the cavity must be continued. This is as indispensable as the curetting. After a time the drain may be replaced by a strip of iodoform gauze, allowing the wound to fill up little by little.

No matter how carefully the curetting is done, it is often incomplete; the granulations in front of the nerve roots are scarcely touched.

Certain contra-indications to operation must be taken into consideration.

(*a*) *The General Condition of the Patient.*—An advanced pulmonary tuberculosis or a sudden increase of the tubercular trouble, or a grave generalization in other viscera, contra-indicate operation here as in all other surgical tuberculosis.

(*b*) *Bony Lesions.*—When the bony lesions have extended to several vertebral bodies, encroaching backward on the articular processes and the laminæ, operation is not only useless but dangerous.

(*c*) *Medullary Lesions.*—The commonly successful results in medullary lesions after simple orthopædic treatment is a contra-indication to operation. Nearly always when the granulations disappear or when a cold abscess with compressing intraspinal diverticuli is opened, the paraplegic symptoms are overcome.

Most surgeons only operate when there is an old and grave compression. "I only operate," says Kraske, "when there is vesical paralysis; this is such a severe symptom that it justifies everything." "One should only operate," say Bullard and Burrell, "when there is incontinence of fæces and of urine and complete motor-sensory paralysis below the compression—that is to say, when there is a progressive and sure progress toward a fatal termination."

Others, on the contrary, think that it would be useless to wait for accidents and possible grave extension for the proper time to operate, but either operate systematically in all cases or in a certain number only with a certain evolution; thus in a recent work M. Babinski, after having separated from the paraplegias of Potts' disease a group of paraplegias without lesions appreciable under the microscope, adds: "It must be admitted that among these patients the organic resistance of the cord is not unlimited, and it is proper to suppose that in time the compression would provoke a spinal lesion. On the other hand, it is rational to believe that overcoming this lesion would obtain the disappearance of the functional troubles which depend upon it. The operation appears to me, then, to have a double indication, for it can be considered as a preventive and a curative measure."

In paraplegia from compression due to anterior pachymeningitis the difficulty is to decide when to operate. If delayed too long, we may have an incurable spinal cord lesion and a very unfavorable general condition and extended bony disease, while if the operation is performed early, we may subject the patient to an operative manipulation when he would have recovered by other methods. Neither of these cases should be operated upon, but this method should be applied to the few that occupy the middle ground.

A special and urgent indication has been supposed to be present in the cases where there was pulmonary difficulty, due to the height of the lesion, but the results of operation in these cases is not encouraging, most of the patients having died very soon after the operation.

There remains to be tried as an adjuvant to other measures

Hadra's method of suturing the transverse processes. In medullary tubercle all surgical treatment is useless. It is in our opinion the same with tuberculosis of the pia mater, which develops usually in the form of granulations, extending for a greater or less distance from the dural lesion, and like those granulations that Schede found in the autopsy on one of his patients. Occasionally it develops in the form of a large localized tubercle. This last variety seems at the first glance to justify intervention, but if this is undertaken there is great risk of not being able to draw the membranes together again, and of causing a septic or tubercular meningeal infection, or a cerebro-spinal fistula.

Moreover, the intradural tubercle may not be at the same level as the peripachymeningitis.

Rarer still are tuberculous cerebro-spinal fistulæ, which require for their production three exceptional conditions: posterior Potts' disease, dural perforation, a cutaneous opening. Meningeal infection through this fistula may be possible; it is necessary, therefore, we believe, to make a large and prudent clearing out of the tubercular spaces, perhaps suture of the dura mater, after ablation of the diseased portion, but in all cases an active treatment is rendered indispensable by the gravity of the probable accidents. If this is impossible then attentive dressings and antisepsis of the tuberculous fistula should be carried out.

When a cold abscess ruptures into the œsophagus, the pleura, bronchi or intestine, while the prognosis is bad, and there is probably very little to be obtained from operation, still it should be attempted.

(3) *Tumors.*—Some surgeons have opened hydatid cysts, believing them to be cold abscesses of vertebral origin, others have excised the spinous processes or transverse processes in connection with a tumor, ordinarily fibroma or sarcoma, which they have extirpated. This is not truly the surgery of the spine, and does not concern us.

Without considering some cases of accidental opening of the spine, and spite of the purely theoretical advice of Cruveilhier, Leyden and Bramwell, there was no typical and regular operation for the removal of a tumor before that of Bazy (October, 1887) and Gowers and Horsley (June, 1888).

This last gave the necessary impetus to this work, so that Chipault has been able to collect more than twenty operations for medullary or retro-medullary tumors compressing the cord. These facts, taken in conjunction with clinical observation, have permitted the determination of the precise cases where surgical intervention is indicated.

(*a*) *Intra-medullary Tumors.*—Ordinarily in these tumors the neoplastic element slowly substitutes itself for the nervous elements rather than compressing them mechanically. Their ablation would only then aggravate the symptoms.

Very exceptionally, the tumor is encapsulated, and escapes on simple incision.

The surgery of intra-medullary encapsulated tumors does not yet furnish us with sufficient facts for or against the operative treatment. This is also true of the puncture of intra-medullary liquid tumors, hydatid cysts, dermoid cysts, and abscess.

(*b*) *Extra-medullary Tumors.*—These tumors, much less rare than the preceding, may be of extra-spinal origin, spreading secondarily to the canal, of spinal or bony origin, of intra-spinal origin, and may be extra- or intra-dural.

(*a*) Certain of them absolutely do not justify an operation. We have no need to cite aneurism and cancer. These usually attack the vertebral bodies secondarily. This is also true in posterior malignant tumors which, however, against all surgical rules, have been operated upon, usually with deplorable results. It is also true of a certain number of intra-spinal tumors which are disseminated more or less over the meningeal canal. In these cases, as well as in those where the diffuse intra-dural lesion is due to tuberculosis, or syphilis, the operation if it has been begun through an error of diagnosis can only be exploratory.

(*b*) Much more frequent, however, are the cases of extra-medullary tumor when the operation, more or less easily performed, will lead to the most happy results.

(1) Sometimes it affects tumors with extra-spinal connections. The lipomata having without doubt their point of origin in the retro-meningeal fatty tissue have for a long time yielded fortunate results.

Hydatid cysts with an extra-spinal tumor have not given any better results than obtain in analogous cases elsewhere.

(2) Septic infection from pre-operative infection is fatal.

Successes here are still more surprising, because these intra-spinal tumors always lead to certain death either by exhaustion or by bed sores, vesico-renal, or pulmonary infection.

But the 150 autopsies prove that these tumors often present themselves under excellent conditions for operation; usually posterior or postero-lateral, of small volume, fixed either upon the pia mater or visceral arachnoid, or enveloping the nerves, or upon the internal or external face of the dura mater, by a very slender pedicle, or by a larger insertion, but made up of lax connective tissue, there are few or no adhesions, and they are entirely separated from the neighboring parts by their surrounding stroma. Therefore, whether they are extra- or intra-dural, extirpation is easy, relapse improbable. There is no destruction of the medullary substance, but only a slow compression, causing late medullary lesions like those in Potts' disease, and like them also liable to recovery, once the cause of compression is removed.

A case cannot be surely counted upon after a very prolonged compression. The age and intensity of curable compressions from extra-medullary tumor remain the only obscure points in their surgical study.

DIVERSE INDICATIONS.

Bony Lesions.—First of all, the different non-tubercular osteites. Traumatic vertebral osteitis, except compound fractures and gunshot wounds, is uncommon.

Certainly entirely distinct from the foregoing and from all other varieties of vertebral osteitis is the osteomyelitis of the spine.

The osteitis and other syphilitic lesions of the vertebra have also been operated upon.

The different lesions of the coccyx are also susceptible to surgical treatment under the name of coccygodynia. Formerly it was nearly always considered a simple neuralgia, and for its relief the ligaments and muscles attached to the bone were simply cut with the idea of cutting the nerves.

Our statistics show that coccygodynia is almost always the result of a fracture, a subluxation, sprain of the coccyx (lesions due to confinement or any other traumatism), and to a displacement and increased mobility of the bone.

It should then either be sutured to the sacrum or simply resected. The latter in nearly all cases has given the best results.

Meningeal Lesions.—Rarer and less known still than the preceding bony lesions are most of the meningeal lesions.

There is practically very little of value in this class.

The hypertrophic cervical pachymeningitis, "forming a circumscribed meningeal tumor of slow and fatal progress," can, according to Wyeth and Mills, be successfully treated.

We do not know of any operative attempt made on this disease, which, perhaps, will soon lose its individuality and become only a clinical type of different affections, such as hysteria, medullary sclerosis, meningeal tuberculosis, etc., none of which are operable.

A double trepanation, with lavage and drainage, is indicated in some cases of generalized suppurative perimeningitis without bony lesion. Here there is no danger of doing harm to the patient, as all the cases up to the present time have died.

Other operators have attempted the regulation of cerebro-spinal pressure by a trepanation and intra-dural drainage or punctures of the spine in tuberculous cerebral meningitis and hydrocephalus. If there is tumor or meningitis, operation can only be palliative. In coma, which in the course of these lesions might lead to death, there have been some results, but so slight and transitory as to be worthless. In hydrocephalus lumbar evacuation was expected to be curative, but up to the present time the facts do not realize this hope any more than drainage of the lateral ventricles. Lumbar evacuation, permanent or intermittent, constitutes in hydrocephalus a sufficient and logical treatment. Both diminish the cranial contents without affecting the bony envelope, but after more or less considerable extraction of the cephalo-rachidian fluid the cranium, even that of an hydrocephalic, does not retract its walls or fold its fontanelles enough to make up for the deficiency in the space that has been made. A congestion of the brain would result, and even a trouble of the general circulation, because of the quantity of blood which flows into the nerve centres and the pia plexus that surrounds them.

This sudden congestion is probably the cause of serious catastrophies that have followed the cerebral or lumbar punctures. They should be preceded by large craniotomies of a kind to allow the cranial vault to contract greatly under a graduated elastic pressure, when later on it could be emptied, preferably by lumbar puncture, and not interrupting the cranial shrinkage.

It remains to be seen whether hydrocephalic patients can endure these multiple and grave operations, and derive any benefit from them.

(*c*) *Spinal Cord Affections.*—In this group, which is more important than the other two, since it covers all medical affections of the spine and the cord, much has been attempted in different ways.

The principal success has been in intra-spinal section of the posterior nerve roots for intractable neuralgias. They have the following advantages:

(1) To prevent more surely than a lower section the course of an ascending neuritis, the superior limits of which are not known.

(2) To permit in cases of difficult diagnosis the exploration of the spinal canal, and if a tumor, the product of an inflammatory process, causing nerve or medullary compression, exits to remove it.

(3) To limit the section to the posterior roots, which prevents paralysis of the territory whose nerve supply is derived from the corresponding anterior root.

The opening of the dura mater and the intra-dural section will be naturally necessary to obtain this last result.

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